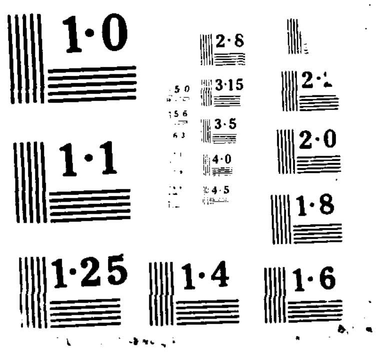
LASER RADIATION(U) PHYSICAL SCIENCES INC ANDOVER MA
@ GELB 15 MAY 87 AFOSR-TR-88-0304 F49620-84-C-0102

UNCLASSIFIED F/G 7/4 NL


1·0
2·8
3·15
3·5
4·0
4·5
2·0
1·1
1·8
1·25
1·4
1·6

DTIC FILE COPY

(2)

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED

1b. RESTRICTIVE MARKINGS

3. DISTRIBUTION/AVAILABILITY OF REPORT
Approved for public release, distribution unlimited

AD-A192 954

DTIC ELECTE MAR 3 0 1988 D

5. MONITORING ORGANIZATION REPORT NUMBER(S)
AFOSR-TR- 88-0334

6a. NAME OF PERFORMING ORGANIZATION
Physical Sciences Inc

6b. OFFICE SYMBOL (If applicable)

7a. NAME OF MONITORING ORGANIZATION
AFORS/NE

6c. ADDRESS (City, State and ZIP Code)
Research Park, P O Box 3100
Andover, MA 01810

7b. ADDRESS (City, State and ZIP Code)
Bldg 410
Bolling AFB, DC 20332-6448

8a. NAME OF FUNDING/SPONSORING ORGANIZATION
AFOSR

8b. OFFICE SYMBOL (If applicable)
NE

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
F49620-84-C-0102

8c. ADDRESS (City, State and ZIP Code)
Bldg 410
Bolling AFB, DC 20332-6448

10. SOURCE OF FUNDING NOS.

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.
61102F	3005	A1	

11. TITLE (Include Security Classification)
The Use of Liquid Films for Spacecraft Surviability to Laser Radiation

12. PERSONAL AUTHOR(S)
Gelb

13a. TYPE OF REPORT
Final Report

13b. TIME COVERED
FROM 840901 TO 860831

14. DATE OF REPORT (Yr., Mo., Day)
870515

16. SUPPLEMENTARY NOTATION

17. COSATI CODES

FIELD	GROUP	SUB. GR.

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This contains the results of a phase II SBRI program to investigate the concept of liquid film protection of spacecraft materials from laser interaction. The liquid film protection concept consists of using a reflective thin film coating over a graphitic substrate to reduce the absorbed laser energy and hence the degree of damage caused by the laser interacation. The required properties of thin film are: 1) it liquifies a temperatures substantially below that for substantial substrate vaporization, 2) its vaporization temperature is much higher than the substrate, and 3) the liquified film must allow the passage of substrate vaporization products through it without destroying the film coherence.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT
UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS ☐

21. ABSTRACT SECURITY CLASSIFICATION
UNCLASSIFIED

22a. NAME OF RESPONSIBLE INDIVIDUAL
JOSEPH W HAGER MAJ USAF

22b. TELEPHONE NUMBER (Include Area Code)
(202) 767-4933

22c. OFFICE SYMBOL
NE

DD FORM 1473, 83 APR   EDITION OF 1 JAN 73 IS OBSOLETE.

SECURITY CLASSIFICATION OF THIS PAGE

AFOSR-TR- 88-

CHAPTER 1 (U)

INTRODUCTION (U)

(U) This contains the results of a Phase II SBIR program to investigate the concept of liquid film protection of spacecraft materials from laser interaction.

(U) The liquid film protection concept consists of using a reflective thin film coating over a graphitic substrate to reduce the absorbed laser energy and hence the degree of damage caused by the laser interaction. The required properties of thin film are: 1) it liquifies at temperatures substantially below that for substantial substrate vaporization, 2) its vaporization temperature is much higher than the substrate, and 3) the liquified film must allow the passage of substrate vaporization products through it without destroying the film coherence.

(U) Requirements 1) and 2) ensure that the liquid film forms before substrate vaporization occurs and that the film will not ablate with the substrate. The third requirement is one of film stability. For high laser intensities temperatures will be reached such that carbon vaporization will occur. In order to maintain the reduced laser absorbtivity the liquid film must allow vaporization products to be transported through the film without substrate exposure.

(U) In the Phase I program the feasibility of this concept was demonstrated. Experiments were performed in an electron beam apparatus. In a parallel effort the thermodynamics and fluid mechanics of thin liquid films was investigated. Several mechanisms for stable film behavior were identified. These included convective transport driven by surface tension forces. These studies have continued in the Phase II program.

(U) Extensive electron beam testing of coated graphitic samples was conducted in the first year of the Phase II program. These measurements were

88 8 23 188

(U) used to investigate coating materials in addition to those used in the Phase I. The effect of substrate was examined by measuring film behavior over a number of graphitic materials. Also in the first year of the Phase II program, low power laser tests were conducted. In the second year effort electron beam measurements were made of coating performance at near visible wavelengths. Earlier measurements had considered their behavior at infrared wavelengths. The major experimental effort of the second year was to perform high power CW laser tests at the EDCL II facility at the Air Force Weapons Laboratory. These tests provide data at interaction intensities hereto not available and are a critical test for the liquid film protection concept.

(U) The Phase II modeling and theory effort was concerned with further understanding the thermodynamic behavior and fluid mechanics of substrate transport through a liquified layer. Phase relationships were analyzed for the various coating materials. A model for the fluid mechanics was developed in the first year. The second year effort implemented the model in order to predict film behavior under a variety of conditions.

(U) The focus of this effort, both experimental and theoretical, is to understand the behavior of interface of a coated substrate during ablation. The immediate motivation of this work was the development of the liquid film protection concept. However, this phenomena is also critical to the functioning of volumetrically loaded carbons, i.e., TBR materials. The results and insights from this effort are pertinent to the design and functioning of these materials as well.

(U) The organization of the report is as follows. The primary emphasis is on the second year's effort of the Phase II program. The first year's effort has already been presented in detail. Chapter 2 presents the results of the high power laser tests at AFWL. Chapter 3 presents optical properties measurements at near visible wavelengths in the PSI electron beam apparatus. The fluid mechanics modeling results are presented in Chapter 4.

A-1

END
DATE
FILMED
DTIC
6-88